

Comparative efficacy of various insecticides against flea beetle (*Phyllotreta cruciferae* Goeze and *Monolepta signata* Olivier), infesting rapeseed-toria (*Brassica rapa* L.) in Odisha

ABSTRACT

A field study was carried out at the instructional farm of College of Horticulture, OUAT, Chiplima, Odisha to evaluate the field efficacy of different botanical, microbial, and novel insecticides viz., T₁: *Azadirachta indica* 300 ppm @2500ml/ha, T₂: *Bacillus thuringiensis* @2500ml/ha, T₃: *Lecanicillium lecanii* @2500ml/ha, T₄: Spinetoram 11.7 % SC @500 ml/ha, T₅: Diafenthiuron 50 % WP @600g/ha, T₆: Chlorantraniliprole @150ml/ha against flea beetle (*Phyllotreta cruciferae* Goeze and *Monolepta signata* Olivier) infesting rapeseed-toria (*Brassica rapa* L.) variety "Sushree" in randomized block design (RBD), seven treatments replicated thrice during two consecutive *Rabi* seasons in 2021-22 and 2022-23. The pooled mean results revealed that the treatment (T₄) spinetoram 11.7 % SC @500ml/ha applied at 15 days interval (Three times) was comparatively effective among the tested treatments in suppressing flea beetle (2.61 grubs+adults plant⁻¹ with 70.06% ROC). In contrast, the treatment (T₅) diafenthuron 50% WP @600g/ha was found to be relatively safer towards natural enemies population, i.e., predatory coccinellid beetle (4.41 grubs+beetle plant⁻¹ with 11.82% ROC), syrphid fly (1.68 maggots plant⁻¹ with 15.57% ROC) and spider (0.84 spiders plant⁻¹ with 20.75% ROC), under field conditions in west-central table land of Odisha.

Keywords: Efficacy; insecticides; rapeseed-toria; flea beetle; natural enemies.

1. INTRODUCTION

The cruciferous oilseed species of *Brassica*, commonly referred to as rapeseed-mustard, represents a crucial agricultural commodity globally. This group encompasses eight species, including Indian mustard, toria, yellow sarson, brown sarson, gobhi sarson, karan rai, black mustard, and taramira. These crops are extensively cultivated across 53 countries worldwide, emphasizing their significant economic importance in agriculture [1]. Toria (*Brassica rapa* Linnaeus, 2n = 20) is a major oilseed crop in the Indian subcontinent, primarily cultivated during the *Rabi* season. It belongs to the *Brassicaceae* family and is commonly referred to as sarson or lahi, whose origins trace back to South-East Asia, where it emerged from the hybridization of *B. nigra* and *B. campestris* [2,3,4]. Rapeseed-mustard plays a crucial role in India's edible oil sector, accounting for nearly 80% of the total *Rabi* oilseed production [5].

However, the yields of crops are significantly plagued and hindered by various insect pests [6]. Among them, mustard flea beetle (*Phyllotreta cruciferae* Goeze) is a major pest impacting rapeseed and toria in India, especially during the seedling stage [7]. This beetle is known to inflict considerable damage, particularly on early-sown crops. Research indicates that flea beetle activity peaks between October and December, which results in stunted plant growth and diminished crop yields in some regions [8]. Apart from this, the white spotted flea beetle, *Monolepta signata* Olivier significantly affects rapeseed-toria crop yield causing severe defoliation at the young seedling stage [9,10]. Nonetheless, pest density in the crop ecosystem

has often been attenuated by several natural enemies and predators like coccinellid beetles, syrphid flies, and spiders [11].

Common mitigation strategies against insect pests may include extensive and unregulated application of conventional chemical pesticides, nevertheless, it has been shown to not only accelerate the development of insecticide resistance but also result in pest resurgence, environmental pollution, harm to non-target organisms, and accumulation of harmful residues in the food chain [12]. To address these challenges, integrated pest management (IPM) practices, such as adjusting sowing times and employing novel insecticides with improved efficacy are increasingly recommended to protect mustard crops in India. Consequently, there is an urgent need for both safer and more effective insecticides, featuring diverse modes of action to delay resistance. Researchers have increasingly emphasized the adoption of next-generation insecticides with biopesticides as sustainable solutions for pest control [13] in rapeseed-toria cultivation and so is the present field experiment.

2. MATERIALS AND METHODS

The field experiment was conducted for two consecutive *Rabi* seasons of 2021/22 and 2022/23 at the Experimental Farm, College of Horticulture, Odisha University of Agriculture and Technology, Chiplima, Odisha. "Sushree" variety was sown during mid-October of 2021 & 2022 in randomized block design (RBD), seven treatments replicated thrice on plots of size (4 m x 5 m) 20 m² each with 30 cm X 10 cm plant to row spacing and at 5kg/ha seed rate. All recommended agronomical practices were followed to raise the crop.

2.1 Observations on insect-pest and natural enemies' population and treatment details

A random sample of flea beetle and natural enemies' population on ten plants was taken from both the treated and untreated plots to evaluate the field efficacy of six different botanical, microbial, and novel insecticides viz., T1: *Azadirachta indica* 300 ppm @2500ml/ha, T2: *Bacillus thuringiensis* @2500ml/ha, T3: *Lecanicillium lecanii* @2500ml/ha, T4: Spinetoram 11.7 %SC @500 ml/ha, T5: Diafenthiuron 50 % WP @600g/ha, T6:Chlorantraniliprole @150ml/ha applied in each treatment plot of each replication once, at 85% plant emergence *i.e.*, 30 days after sowing (DAS), repeated at 15 days after first scheduled application *i.e.*, 45 DAS and likewise at 15 days after the 2nd scheduled application *i.e.*, 60 DAS for the management of flea beetle on rapeseed-toria, then compared with untreated control.

2.1.1 Average population count of insect-pest and natural enemies

In each plot, ten plants were selected randomly, and from each plant, an average number of insects per plant *i.e.*, Flea beetle (No. of grubs+adults plant⁻¹), Coccinellid beetles (No. of grubs+adults plant⁻¹), Syrphid fly (No. of maggots plant⁻¹) and Spider (No. of adults plant⁻¹) was calculated.

To assess the effectiveness of various treatments, observations were made one day in advance *i.e.*, 1 day before application (1 DBA), five days following application *i.e.*, 5 days after application (5 DAA), ten days following application (10 DAA), and fourteen days following application (14 DAA). Following each treatment, a pre- and post-count of insect pest population (No. of grubs plant⁻¹) was recorded.

2.2 Per cent reduction in insect-pest and natural enemies' population in the treated plot over untreated control

The per cent reduction in pest and natural enemies' population count was calculated using the following formula:

$$\text{Per cent reduction in pest or natural enemies over untreated control (\%)} = \frac{\text{Pest or natural enemy population (untreated plot – treated plot)}}{\text{Pest or natural enemy population in the untreated plot}} \times 100$$

2.3 Statistical analysis

The data obtained for various insect counts were subjected to square root transformation. The data was analyzed using the procedures given by Gomez and Gomez [14]. The statement variations were tested for significance by the “F” test. The standard error of means SE(m)± and critical difference (CD) at a 5% significance level was calculated following the standard procedure. Treatment means were compared with a critical difference (CD). Based on the statistically analyzed data, the results of the observations were interpreted and a conclusion was obtained.

3. RESULTS AND DISCUSSION

3.1 Flea beetle

Incidence of two different flea beetle species, *i.e.*, *Phyllotreta cruciferae* and *Monolepta signata*, were observed in the crop ecosystem 4 weeks after sowing (46th Standard Mean Week). This corroborates with the findings of Das [15] and Keot *et al.* [16], who confirmed the pest incidence of flea beetles of both species as well. Figure 1 represents the distribution of the mustard flea beetle and white spotted flea beetle in the rapeseed-toria crop ecosystem, throughout the cropping seasons.

Table 1 presents the pooled analysis data of two years, *i.e.*, two consecutive *Rabi* seasons of 2021/22 and 2022/23, on the comparative efficacy of various insecticides against the flea beetle population on rapeseed-toria. Before initiating the first application, the population recorded in the treatment plots varied from 7.07 to 10.00 grubs+adults plant⁻¹.

The results reveal that the “spinetoram (T₄)” was found to be effective among all treatments with 2.61 grubs+adults plant⁻¹ and 70.06% reduction in population over untreated control (ROC), followed by “*Lecanicillium lecanii* (T₃)” recording 3.07 grubs+adults plant⁻¹ with 64.79% ROC. The percent reduction in the rest of the treatments varied within the 44.10 to 60.47 % range. Similar results were reported by Srinivasana *et al.* [17] which concluded that three applications of foliar spray of spinetoram 10% w/w + sulfoxaflor 30% w/w WG @350 ml/ha and spinetoram 10% + sulfoxaflor 30% WG @300 ml/ha were superior and effective in reducing the flea beetle damage.

The order of efficacy (in descending order) of different treatments tested against the flea beetle population concerning reduction percentage over control is as follows:

(T₄): Spinetoram 11.7 % SC @500 ml/ha (70.06% ROC) > (T₃): *Lecanicillium lecanii* @2500ml/ha (64.79% ROC) > (T₆): Chlorantraniliprole 18.50 % SC @150 ml/ha (60.55% ROC) > (T₅): Diafenthiuron 50% WP @600 g/ha (58.37% ROC) > (T₁): *Azadirachta indica* 300ppm @2500ml/ha (48.39% ROC) > (T₂): *Bacillus thuringiensis* @2500 ml/ha (44.15% ROC).

3.2 Natural enemies (predators)

Apart from flea beetles, three natural enemies (predators) viz. Coccinellid beetles, Syrphid flies, and Spiders associated with the major rapeseed-toria/mustard crop pests were observed in the crop field (Figure 2).

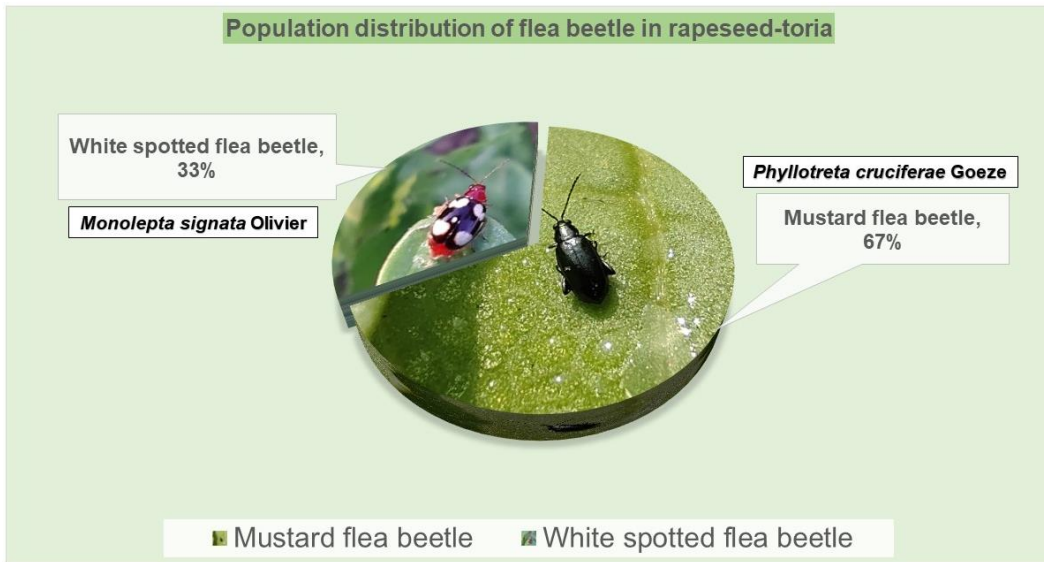


Figure 1. The population distribution of flea beetle species in the rapeseed-toria experimental field-crop ecosystem (Rabi of 2021/22 and 2022/23)

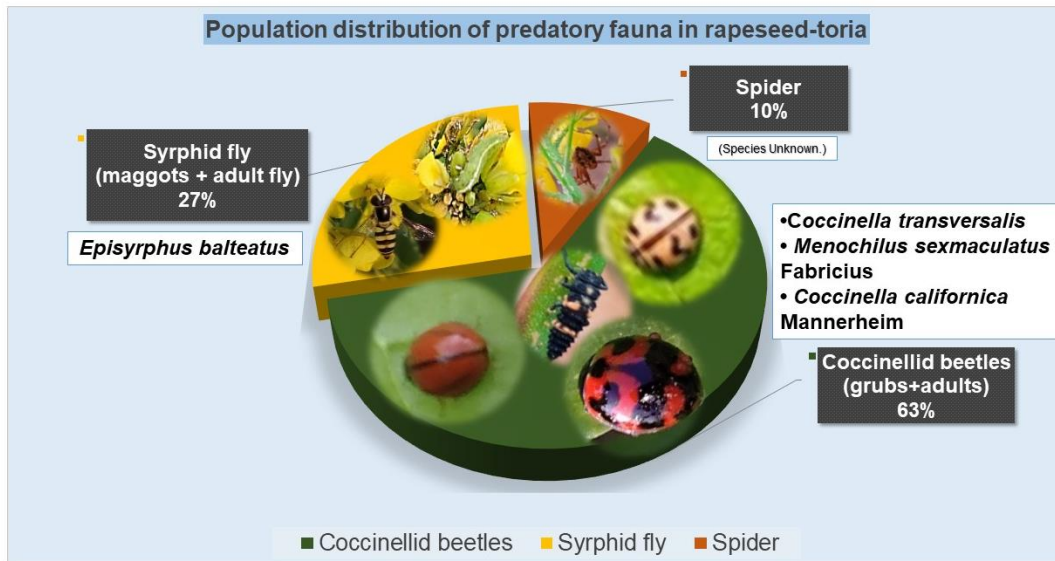


Figure 2. The population distribution of predatory fauna in the rapeseed-toria experimental field-crop ecosystem (Rabi of 2021/22 and 2022/23)

The pooled analysis data of two years, i.e., two consecutive Rabi seasons of 2021/22 and 2022/23, for comparative efficacy of various novel insecticides on coccinellid beetles (Table 2), reveals that “diafenthiuron 50% WP @600g/ha (T₅)” was relatively safer with least reduction of the population over untreated control (4.40 grubs+adults plant⁻¹ with 11.82% ROC), followed by “spinetoram 11.7 % SC @500 ml/ha (T₄)” which had 4.29 grubs+adults

plant⁻¹ with 14.02% ROC. Likewise for syrphid fly, “diafenthiuron 50% WP @600g/ha (T₅)” was comparatively safer with 1.68 maggots plant⁻¹ (Table 3) and 15.57% ROC followed by “chlorantraniliprole 18.50 % SC @150ml/ha (T₆)” which had 1.48 maggots plant⁻¹ with 25.62% ROC. In addition, for the spider population, “diafenthiuron 50% WP @600g/ha (T₅)” was relatively safer with least reduction of the population over untreated control (0.84 adults/plant and 20.75% ROC) followed by “chlorantraniliprole 18.50 % SC @150ml/ha (T₆)” which had 0.78 adults plant⁻¹ with 26.41% ROC (Table 4). The findings resembled the outcomes by Bajya *et al.* [18], it was concluded that diafenthiuron 47.8 SC @ 286.8 g a.i./ha was highly effective in suppressing the sucking pests, and it had no adverse effects on the natural enemies.

4. CONCLUSION

From the present study, it can be concluded that the novel insecticide, “spinetoram 11.7% SC @500ml/ha (T₄) at 15 days intervals (Three times)” was comparatively effective against both the species of flea beetle infesting rapeseed-toria under field conditions. However, “diafenthiuron 50% WP @600gm/ha (T₅) at 15 days intervals (Three times)” was found to be relatively safer towards coccinellid beetles, syrphid fly, and spiders, for both the experimental years (*Rabi* of 2021/22 and 2022/23) in the west-central tableland region of Odisha, India.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during the writing or editing of this manuscript.

Table 1: Comparative efficacy of botanical, microbial, and novel insecticides against flea beetle in rapeseed-toria under field conditions (Pooled data of Rabi, 2021/22 and 2022/23)

Treatments	Pooled Mean population of flea beetle (No. of grubs+adults/plant)													Overall pest count	Reduction over untreated control (%)
	1 st Application (Mean of two years)					2 nd Application (Mean of two years)				3 rd Application (Mean of two years)					
	1 DBA	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean		
T1: Azadirachtin 300 ppm	10.00 (3.17)	4.44 (2.12)	4.22 (2.07)	4.05 (2.02)	5.68	3.85 (1.97)	3.80 (1.96)	3.84 (1.97)	3.83	3.62 (1.91)	3.43 (1.87)	3.37 (1.85)	3.47	4.50	48.39
T2: <i>Bacillus thuringiensis</i>	8.69 (2.96)	5.43 (2.34)	5.26 (2.30)	4.92 (2.23)	6.08	4.67 (2.17)	4.49 (2.13)	4.45 (2.12)	4.54	4.25 (2.07)	4.39 (2.11)	4.43 (2.12)	4.35	4.87	44.15
T3: <i>Lecanicillium lecanii</i>	8.33 (2.90)	2.54 (1.61)	2.18 (1.49)	1.99 (1.43)	3.76	1.73 (1.33)	1.35 (1.18)	1.24 (1.14)	1.44	0.75 (0.89)	0.72 (0.88)	0.57 (0.79)	0.68	3.07	64.79
T4: Spinetoram 11.7% SC	7.07 (2.67)	1.70 (1.32)	1.34 (1.18)	1.25 (1.14)	2.84	1.13 (1.09)	1.05 (1.05)	0.80 (0.92)	0.99	0.43 (0.70)	0.27 (0.57)	0.14 (0.44)	0.28	2.61	70.06
T5: Diafenthiuron 50% WP	8.33 (2.89)	3.21 (1.81)	2.86 (1.71)	2.95 (1.73)	4.34	2.65 (1.64)	2.51 (1.60)	2.50 (1.60)	2.56	2.42 (1.57)	2.60 (1.63)	2.46 (1.59)	2.50	3.63	58.37
T6: Chlorantraniliprole 18.50% SC	8.10 (2.85)	3.11 (1.78)	3.12 (1.78)	2.51 (1.60)	4.21	2.17 (1.49)	2.13 (1.48)	2.07 (1.46)	2.12	1.98 (1.43)	1.89 (1.39)	1.51 (1.25)	1.79	3.44	60.55
T7: Untreated control	9.08 (3.02)	9.53 (3.10)	10.53 (3.25)	11.77 (3.44)	10.23	12.33 (3.52)	11.54 (3.40)	11.89 (3.45)	11.92	12.26 (3.51)	11.53 (3.40)	12.45 (3.54)	12.08	8.72	-
SE(m) ±	0.122	0.073	0.077	0.207	-	0.084	0.103	0.055	-	0.158	0.121	0.146	-	-	-
CD (P= .05)	NS	0.22	0.23	0.63	-	0.25	0.31	0.17	-	0.48	0.37	0.44	-	-	-

*Figures in parentheses are square root transformed values.

DBA: Days before application

DAA: Days after application

Table 2: Comparative efficacy of botanical, microbial, and novel insecticides on Coccinellid beetle in rapeseed-toria under field conditions (Pooled data of Rabi, 2021/22 and 2022/23)

Treatments	Pooled Mean population of Coccinellid beetle (No. of grubs+adults/plant)													Overall insect count	Reduction over untreated control (%)
	1 st Application (Mean of two years)					2 nd Application (Mean of two years)				3 rd Application (Mean of two years)					
	1 DBA	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean		
T1: Azadirachtin 300 ppm	4.94 (2.23)	3.51 (1.89)	3.53 (1.89)	3.57 (1.90)	3.89	3.57 (1.90)	3.68 (1.93)	3.67 (1.93)	3.64	3.63 (1.92)	3.68 (1.93)	3.68 (1.93)	3.66	3.73	25.25
T2: <i>Bacillus thuringiensis</i>	4.81 (2.21)	3.71 (1.94)	3.31 (1.83)	3.12 (1.78)	3.74	3.10 (1.77)	2.98 (1.74)	2.85 (1.70)	2.98	2.33 (1.54)	2.25 (1.52)	2.22 (1.51)	2.27	2.99	40.08
T3: <i>Lecanicillium lecanii</i>	4.97 (2.24)	3.91 (1.99)	3.12 (1.78)	3.08 (1.77)	3.77	3.07 (1.77)	3.01 (1.75)	2.86 (1.70)	2.98	2.45 (1.58)	2.34 (1.55)	2.34 (1.55)	2.38	3.04	39.07
T4: Spinetoram 11.7% SC	4.34 (2.10)	4.22 (2.07)	4.35 (2.10)	4.48 (2.13)	4.35	4.21 (2.06)	4.44 (2.12)	4.37 (2.10)	4.34	4.21 (2.06)	4.15 (2.05)	4.15 (2.05)	4.17	4.29	14.02
T5: Diafenthiuron 50% WP	4.66 (2.17)	4.08 (2.03)	4.13 (2.04)	4.35 (2.10)	4.31	4.12 (2.04)	4.49 (2.13)	4.49 (2.13)	4.36	4.56 (2.15)	4.52 (2.14)	4.52 (2.14)	4.54	4.40	11.82
T6: Chlorantraniliprole 18.50% SC	4.77 (2.20)	4.05 (2.02)	4.03 (2.02)	3.99 (2.01)	4.21	3.69 (1.93)	3.84 (1.97)	3.64 (1.92)	3.72	3.63 (1.92)	3.63 (1.92)	3.64 (1.92)	3.64	3.86	22.64
T7: Untreated control	4.77 (2.20)	4.47 (2.13)	4.95 (2.24)	4.60 (2.16)	4.70	4.78 (2.20)	4.68 (2.17)	5.12 (2.27)	4.86	4.96 (2.24)	5.67 (2.39)	5.66 (2.39)	5.43	4.99	-
SE(m) ±	0.043	0.050	0.036	0.087	-	0.051	0.042	0.104	-	0.038	0.053	0.051	-	-	-
CD (<i>P</i> =.05)	NS	0.15	0.11	0.26	-	0.15	0.13	0.31	-	0.12	0.16	0.15	-	-	-

*Figures in parentheses are square root transformed values.

DBA: Days before application

DAA: Days after application

Table 3: Comparative efficacy of botanical, microbial, and novel insecticides on Syrphid fly in rapeseed-toria under field conditions (Pooled data of Rabi, 2021/22 and 2022/23)

Pooled Mean population of Syrphid fly (No. of maggots/plant)															
Treatments	1 st Application (Mean of two years)					2 nd Application (Mean of two years)				3 rd Application (Mean of two years)				Overall insect count	Reduction over untreated control (%)
	1 DBA	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean		
T1: Azadirachtin 300 ppm	1.59 (1.28)	1.37 (1.19)	1.30 (1.16)	1.29 (1.16)	1.39	1.28 (1.15)	1.27 (1.15)	1.27 (1.15)	1.28	1.24 (1.14)	1.22 (1.13)	1.21 (1.12)	1.22	1.30	34.67
T2: <i>Bacillus thuringiensis</i>	1.68 (1.32)	1.49 (1.24)	1.46 (1.23)	1.46 (1.23)	1.52	1.42 (1.21)	1.42 (1.21)	1.40 (1.20)	1.42	1.37 (1.19)	1.34 (1.18)	1.34 (1.18)	1.35	1.43	28.14
T3: <i>Lecanicillium lecanii</i>	1.56 (1.27)	1.43 (1.22)	1.43 (1.22)	1.40 (1.20)	1.46	1.36 (1.19)	1.35 (1.18)	1.35 (1.18)	1.36	1.31 (1.17)	1.29 (1.16)	1.29 (1.16)	1.30	1.37	31.15
T4: Spinetoram 11.7% SC	1.78 (1.35)	1.25 (1.14)	1.14 (1.09)	1.11 (1.08)	1.32	1.11 (1.08)	1.04 (1.04)	1.03 (1.04)	1.06	0.97 (1.01)	0.91 (0.98)	0.87 (0.96)	0.92	1.10	44.72
T5: Diafenthiuron 50% WP	1.73 (1.33)	1.69 (1.32)	1.68 (1.32)	1.67 (1.31)	1.69	1.67 (1.31)	1.68 (1.31)	1.68 (1.31)	1.67	1.67 (1.31)	1.66 (1.31)	1.67 (1.31)	1.67	1.68	15.57
T6: Chlorantraniliprole 18.50% SC	1.49 (1.24)	1.52 (1.25)	1.51 (1.25)	1.48 (1.24)	1.50	1.47 (1.23)	1.46 (1.23)	1.46 (1.23)	1.47	1.46 (1.23)	1.45 (1.22)	1.47 (1.23)	1.46	1.48	25.62
T7: Untreated control	1.56 (1.27)	1.63 (1.29)	1.71 (1.33)	1.87 (1.38)	1.69	1.89 (1.39)	1.89 (1.39)	1.93 (1.39)	1.90	2.12 (1.47)	2.33 (1.54)	2.63 (1.64)	2.36	1.99	-
SE(m) ±	0.133	0.115	0.083	0.054	-	0.056	0.058	0.056	-	0.088	0.069	0.045	-	-	-
CD (P= .05)	NS	0.35	0.25	0.16	-	0.17	0.18	0.17	-	0.27	0.21	0.14	-	-	-

*Figures in parentheses are square root transformed values.

DBA: Days before application

DAA: Days after application

Table 4: Comparative efficacy of botanical, microbial, and novel insecticides on Spider in rapeseed-toria under field conditions (Pooled data of Rabi, 2021/22 and 2022/23)

Pooled Mean population of Spider (No. of adults/plant)															
Treatments	1 st Application (Mean of two years)					2 nd Application (Mean of two years)				3 rd Application (Mean of two years)				Overall count	Reduction over untreated control (%)
	1 DBA	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean	5 DAA	10 DAA	14 DAA	Mean		
T1: Azadirachtin 300 ppm	0.83 (0.94)	0.80 (0.92)	0.78 (0.91)	0.73 (0.88)	0.79	0.70 (0.87)	0.68 (0.85)	0.68 (0.85)	0.69	0.68 (0.85)	0.64 (0.83)	0.64 (0.83)	0.65	0.71	33.01
T2: <i>Bacillus thuringiensis</i>	0.87 (0.96)	0.85 (0.95)	0.81 (0.93)	0.67 (0.85)	0.80	0.64 (0.83)	0.56 (0.78)	0.55 (0.77)	0.58	0.40 (0.67)	0.40 (0.67)	0.40 (0.67)	0.40	0.59	44.33
T3: <i>Lecanicillium lecanii</i>	0.85 (0.95)	0.76 (0.90)	0.68 (0.86)	0.59 (0.80)	0.72	0.55 (0.78)	0.45 (0.70)	0.41 (0.68)	0.47	0.34 (0.68)	0.41 (0.68)	0.54 (0.77)	0.43	0.54	49.05
T4: Spinetoram 11.7% SC	0.89 (0.97)	0.82 (0.93)	0.78 (0.91)	0.74 (0.89)	0.81	0.70 (0.87)	0.66 (0.84)	0.64 (0.83)	0.66	0.63 (0.82)	0.60 (0.81)	0.60 (0.81)	0.61	0.69	34.90
T5: Diafenthiuron 50% WP	0.89 (0.97)	0.86 (0.95)	0.88 (0.96)	0.88 (0.96)	0.88	0.84 (0.94)	0.82 (0.93)	0.82 (0.93)	0.83	0.82 (0.93)	0.83 (0.94)	0.84 (0.94)	0.83	0.84	20.75
T6: Chlorantraniliprole 18.50% SC	0.85 (0.95)	0.81 (0.93)	0.80 (0.92)	0.80 (0.92)	0.82	0.79 (0.91)	0.76 (0.90)	0.76 (0.90)	0.77	0.76 (0.90)	0.77 (0.91)	0.77 (0.91)	0.77	0.78	26.41
T7: Untreated control	0.92 (0.99)	0.94 (1.00)	1.03 (1.04)	1.07 (1.06)	0.99	1.11 (1.08)	1.10 (1.07)	1.07 (1.06)	1.09	1.04 (1.04)	1.11 (1.08)	1.11 (1.08)	1.09	1.06	-
SE(m) ±	0.015	0.033	0.068	0.063	-	0.047	0.059	0.057	-	0.059	0.096	0.131	-	-	-
CD (P= .05)	NS	0.10	0.21	0.19	-	0.14	0.18	0.17	-	0.18	0.29	0.40	-	-	-

*Figures in parentheses are square root transformed values.

DBA: Days before application

DAA: Days after application

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